

In the Claims:

40. (New) A bump forming apparatus comprising:

a bump forming head for forming bumps onto electrodes of a circuit on a charge appearance semiconductor substrate, whereby the charge appearance semiconductor substrate develops an electric charge due to a temperature change during the bump formation;

a heating and cooling apparatus operable to cool the charge appearance semiconductor substrate in a manner to eliminate the electric charge; and

a controller operable to control said heating and cooling apparatus so as to cool the charge appearance semiconductor substrate in the manner to eliminate the electric charge.

41. (New) The bump forming apparatus of claim 40, wherein said controller is operable to control said heating and cooling apparatus so as to control a temperature-decrease gradient of the charge appearance semiconductor substrate from a bump-bonding temperature to room temperature.

42. (New) The bump forming apparatus of claim 41, wherein said heating and cooling apparatus is operable to contact a rear face of the heating and cooling apparatus opposite to a front circuit-formed face of said heating and cooling apparatus during the cooling so as to eliminate the electric charge.

43. (New) The bump forming apparatus of claim 42, wherein said heating and cooling apparatus is operable to preheat the charge appearance semiconductor substrate to nearly the bump-bonding temperature before heating the charge appearance semiconductor substrate to the bump bonding temperature, and said controller is operable to control said heating and cooling apparatus so as to preheat the charge appearance semiconductor substrate.

44. (New) The bump forming apparatus of claim 43, wherein said heating and cooling apparatus includes a bump bonding stage for heating the charge appearance semiconductor

substrate to the bump-bonding temperature, and a cooling device for cooling the charge appearance semiconductor substrate in accordance with a cooling control by said controller.

45. (New) The bump forming apparatus of claim 44, wherein said cooling device includes a heat diffuser member for contacting the rear face of the charge appearance semiconductor substrate, a heating part detachably connected to said heat diffuser member for raising a temperature of said heat diffuser member, and a separator for separating said heat diffuser member and said heating part so as to allow cooling of said heat diffuser member.

46. (New) The bump forming apparatus of claim 43, wherein said heating and cooling apparatus includes a bump bonding stage for heating the charge appearance semiconductor substrate to the bump-bonding temperature, and a preheat device for preheating the charge appearance semiconductor substrate in accordance with the preheat temperature control of said controller.

47. (New) The bump forming apparatus of claim 46, wherein said preheat device includes a heat diffuser member for contacting the rear face of the charge appearance semiconductor substrate, a heating part detachably connected to said heat diffuser member for raising a temperature of said heat diffuser member, and a separator for separating said heat diffuser member and said heating part so as to allow cooling of said heat diffuser member.

48. (New) The bump forming apparatus of claim 42, further comprising a gas supply device for supplying gas to the charge appearance semiconductor substrate at said heating and cooling apparatus, wherein said controller is further operable to control at least one of said gas supply device and said heating and cooling apparatus so as to conduct a warpage correction control for correcting a warpage of the charge appearance semiconductor substrate at said heating and cooling apparatus.

49. (New) The bump forming apparatus of claim 48, wherein said controller is operable to control said gas supply device so as to conduct a blowing control for eliminating the electric charge of the charge appearance semiconductor substrate at said heating and cooling apparatus.

50. (New) The bump forming apparatus of claim 42, further comprising a contact member operable to contact the front circuit-formed face of the charge appearance semiconductor substrate to eliminate the electric charge at the front circuit-formed face.

51. (New) The bump forming apparatus of claim 42, further comprising an ion generator for generating ions to neutralize the electric charge.

52. (New) The bump forming apparatus of claim 51, further comprising a wafer holding part having holding hooks for holding the charge appearance semiconductor substrate and for transferring the charge appearance semiconductor substrate to said heating and cooling apparatus, said wafer holding part and said holding hooks having an insulating material-coated portion whereat the ions generated by said ion generator are applied.

53. (New) The bump forming apparatus of claim 42, wherein said heating and cooling apparatus has a metal-plated portion located so as to contact the rear face of the charge appearance semiconductor substrate to improve heat conductivity between said heating and cooling apparatus and the charge appearance semiconductor substrate and to remove the electric charge.

54. (New) The bump forming apparatus of claim 40, wherein said heating and cooling apparatus is further operable to heat the charge appearance semiconductor substrate to a bump bonding temperature in a non-contact state with respect to the charge appearance semiconductor

substrate, and is operable to cool the charge appearance semiconductor substrate in the non-contact state based on a decrease in temperature control of said controller.

55. (New) The bump forming apparatus of claim 54, wherein said controller is operable to control said heating and cooling apparatus so as to repeatedly perform a temperature decrease and a temperature increase, in which a temperature increase width is smaller than a temperature decrease width.

56. (New) The bump forming apparatus of claim 54, wherein said heating and cooling apparatus is further operable to preheat the charge appearance semiconductor substrate to nearly the bump-bonding temperature before heating the charge appearance semiconductor substrate to the bump bonding temperature, said controller being further operable to control said heating and cooling apparatus so as to preheat the charge appearance semiconductor substrate in a manner to eliminate the electrical charge.

57. (New) The bump forming apparatus of claim 56, wherein said controller is operable to control said heating and cooling apparatus so as to repeatedly perform a temperature increase and a temperature decrease, in which a temperature decrease width is smaller than a temperature increase width.

58. (New) The bump forming apparatus of claim 56, wherein said heating and cooling apparatus includes a bump bonding stage for heating the charge appearance semiconductor substrate to the bump-bonding temperature, and a preheat device for preheating the charge appearance semiconductor substrate in accordance with the preheat temperature control of said controller.

59. (New) The bump forming apparatus of claim 58, wherein said preheat device includes a heat diffuser member arranged opposite the charge appearance semiconductor

substrate, and has far infrared radiation paint on a face opposite the charge appearance semiconductor substrate.

60. (New) The bump forming apparatus of claim 54, wherein said heating and cooling apparatus includes a bump bonding stage for heating the charge appearance semiconductor substrate to the bump-bonding temperature, and a cooling device for cooling the charge appearance semiconductor substrate in accordance with a cooling control by said controller.

61. (New) The bump forming apparatus of claim 60, further comprising an ion generator for generating and applying ions to neutralize the electric charge, said ion generator being located opposite the charge appearance semiconductor substrate at the cooling device.

62. (New) The bump forming apparatus of claim 61, wherein said heating and cooling apparatus further includes a preheat device for preheating the charge appearance semiconductor substrate to nearly the bump bonding temperature in a non-contact state with respect to the charge appearance semiconductor substrate before heating the charge appearance semiconductor substrate to the bump bonding temperature, said controller being operable to control said preheat device so as to remove the electric charge developed by the charge appearance semiconductor substrate due to the temperature rise during preheating, said ion generator being arranged opposite to the charge appearance semiconductor substrate at said preheat device.

63. (New) The bump forming apparatus of claim 61, further comprising a wafer holding part including holding hooks for holding the charge appearance semiconductor substrate, and for transferring the charge appearance semiconductor substrate to said heating and cooling apparatus, said wafer holding part and said holding hooks having an insulating material-coated portion whereat the ions generated by said ion generator are applied.

64. (New) The bump forming apparatus of claim 60, wherein said cooling device has a heat diffuser member arranged opposite the charge appearance semiconductor substrate, and has far infrared radiation paint on a face opposite the charge appearance semiconductor substrate.

65. (New) The bump forming apparatus of claim 60, further including a warpage correction device connected to said bump bonding stage for correcting a warpage of the charge appearance semiconductor substrate on said bump bonding stage.

66. (New) The bump forming apparatus of claim 60, wherein said controller is operable to control said bump bonding stage so as to control a temperature of the charge appearance semiconductor substrate in a manner to correcting warpage of the charge appearance semiconductor substrate on said bump bonding stage.

67. (New) The bump forming apparatus of claim 60, further comprising a gas supply device for supplying gas to the charge appearance semiconductor substrate at said bump bonding stage to eliminate the electric charge, said gas supply device being connected to said bump bonding stage, wherein said controller is further operable to control said gas supply device in a manner to remove the electric charge.

68. (New) The bump forming apparatus of claim 54, further comprising a contact member operable to contact a front circuit-formed face of the charge appearance semiconductor substrate so as to eliminate the electric charge at the front circuit-formed face.